

**CLAIMS**

1. A transducer, comprising:  
a piezoelectric disk having a first diameter;  
a diaphragm disk, fixed to the piezoelectric disk,  
5 the diaphragm disk having a second diameter greater than  
the first diameter; and  
a cover, comprising a convex surface bounded by an  
annulus, which mates with the diaphragm disk to form a  
generally plano-convex volume between the diaphragm disk  
10 and the cover.
2. A transducer according to claim 1, wherein a cross-  
section of the annulus is substantially linear.
3. A transducer according to claim 1 or claim 2,  
wherein a cross-section of the annulus comprises a  
15 sinusoid.
4. A transducer according to any of claims 1-3, wherein  
the convex surface comprises an internal circumference,  
having a diameter substantially equal to the second  
diameter, and a groove formed along the internal  
20 circumference, and wherein the diaphragm disk is retained  
in contact with the cover by the groove.
5. A transducer according to any of claims 1-4, wherein  
the transducer is operative to convert electrical signals  
applied to the piezoelectric disk to sound waves radiated  
25 by the cover.
6. A transducer according to any of claims 1-5, wherein  
the transducer is operative to generate electrical  
signals from the piezoelectric disk responsive to sound  
waves incident on the cover.
- 30 7. A transducer according to any of claims 1-6, wherein  
the diaphragm disk is fixed substantially in parallel  
with and symmetrically to the piezoelectric disk.

8. A transducer according to any of claims 1-7, wherein the diaphragm disk, the piezoelectric disk, and the cover comprise a common axis of symmetry.
9. A loudspeaker, comprising:
- 5 a piezoelectric disk having a first diameter;  
a diaphragm disk, fixed to the piezoelectric disk, the diaphragm disk having a second diameter greater than the first diameter;  
a cover, comprising a convex surface bounded by an
- 10 annulus, which mates with the diaphragm disk to form a generally plano-convex volume between the diaphragm disk and the cover; and  
a labyrinth, which is fixedly coupled to a circumference of the annulus, and which is operative to
- 15 provide a path for sound waves.
10. A loudspeaker according to claim 9, wherein a cross-section of the annulus is substantially linear.
11. A loudspeaker according to claim 9 or claim 10, wherein a cross-section of the annulus comprises a
- 20 sinusoid.
12. A loudspeaker according to any of claims 9-11, wherein the convex surface comprises an internal circumference, having a diameter substantially equal to the second diameter, and a groove formed along the
- 25 internal circumference, and wherein the diaphragm disk is retained in contact with the cover by the groove.
13. A loudspeaker according to any of claims 9-12, wherein the piezoelectric disk is operative to convert electrical signals applied thereto to sound waves, and
- 30 wherein the sound waves are radiated by the cover.
14. A loudspeaker according to any of claims 9-13, wherein the piezoelectric disk is operative to generate

electrical signals responsive to sound waves incident on the cover, so that the loudspeaker acts as a microphone.

15. A loudspeaker according to any of claims 9-14, wherein the diaphragm disk is fixed substantially in parallel with and symmetrically to the piezoelectric disk.

16. A loudspeaker according to any of claims 9-15, wherein the diaphragm disk, the piezoelectric disk, the cover, and the labyrinth comprise a common axis of symmetry.

17. A method for converting between sound and electrical energy, comprising:

providing a piezoelectric disk having a first diameter;

15 fixing a diaphragm disk to the piezoelectric disk, the diaphragm disk having a second diameter greater than the first diameter; and

20 mating a cover, comprising a convex surface bounded by an annulus, with the diaphragm disk to form a generally plano-convex volume between the diaphragm disk and the cover.

18. A method according to claim 17, wherein the convex surface comprises an internal circumference, having a diameter substantially equal to the second diameter, and a groove formed along the internal circumference, the method further comprising retaining the diaphragm disk in contact with the cover by the groove.

19. A method for forming a loudspeaker, comprising:

30 providing a piezoelectric disk having a first diameter;

fixing a diaphragm disk to the piezoelectric disk, the diaphragm disk having a second diameter greater than the first diameter;

mating a cover, comprising a convex surface bounded by an annulus, with the diaphragm disk to form a generally plano-convex volume between the diaphragm disk and the cover; and

5           fixedly coupling a labyrinth to a circumference of the annulus, the labyrinth being operative to provide a path for sound waves.

20. A method according to claim 19, wherein the convex surface comprises an internal circumference, having a  
10 diameter substantially equal to the second diameter, and a groove formed along the internal circumference, the method further comprising retaining the diaphragm disk in contact with the cover by the groove.

21. A method according to claim 19 or claim 20, wherein  
15 fixedly coupling the labyrinth comprises forming a labyrinth groove in the labyrinth, and retaining the annulus in the labyrinth groove.